ECE 403

Design 2

Options Considered, Budget, and Timeline

EEG Monitor for Sleep Research

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Introduction:

This EEG is a simple stripped-down model meant to be used for dream sleep research. When the user exits REM sleep they will be awakened by stimulation in order to increase the chance of the user remembering their dreams. Currently EEG products are quite expensive making them cost prohibitive. This EEG would be relatively cheap which should expand the client base considerably. This product would be useful for anyone looking to delve into their dreams out of curiosity or a more psychological nature. It would also be very useful for therapists or psychologists trying to learn more about their clients or for use in broad based dream research.

Previous Art:

ZEO Personal Sleep Coach

This is a consumer device that interfaces to the user's smart phone or similar device. It includes a sensory headband that monitors EEG waves while the user is sleeping. The information is transmitted wirelessly to a bedside receiver which collects, logs, and analyzes the signals. This unit then provides the user via smart phone application such information as total sleep time, times woken up, time spent in various sleep stages, etc. The user is also given a "sleep score." This uses the patent-pending SoftWave sensor technology. The kit can be purchased for about $99.

Sleeptracker

The sleep tracker is another consumer device which comes in the form of a wristwatch. This device monitors the user as he sleeps and is designed to wake him up during the lightest stage of sleep via a vibrator and/or audible chime. The idea behind this is for the user to be woken up from a lighter stage of sleep versus a deeper stage as this tends to make the user feel more refreshed and less groggy upon waking. The user can set the alarm for a wake-up window rather than specific time and the device will determine the best time to wake the user up. The watch can be purchased for about $150.

Mindwave

Neurosky's Mindwave features research grade EEG. It includes a wireless headset with USB adapter. This device is meant to interface to a PC and includes the software required to do so. The purpose of this device is to conduct research on the

brain waves of students as they interact with math, memory and pattern-recognition type problems.

Other EEG-related pantents:

Patent No. 4,817,627
ELECTROENCEPHALOGRAPHIC MONITORING

Describes a method and apparatus for obtaining an indication of the extent and duration of reduced-power in EEG signals as a basis for determining whether more blood flow to the brain is needed.

Patent No. 5,816,247
MONITORING AN EEG

Describes an apparatus and method of EEG monitoring which provides multi-dimensional classification of EEG samples using a network of multiple outputs.

Battery:

Since the batteries will have to power the microcontroller, sensors, and the actuator they should be at least in the 2000 mAh range.

Duracell DC1500B4N AA battery- NiMH 2650 mAh Cost- around $9

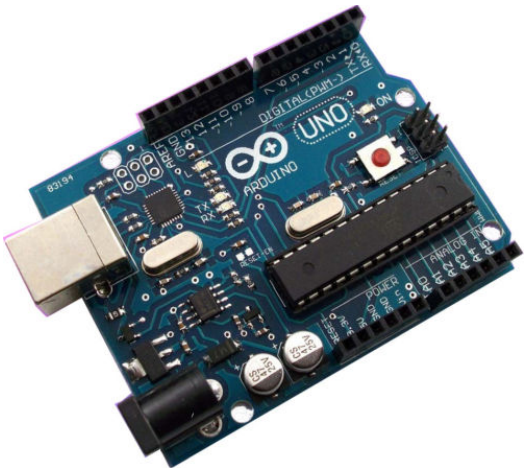
Energizer AA NiMH 2450 mAh Cost- around $12

There are a lot of other rechargeable batteries on the market, these are simply two common ones that are reliable. For the most part prices depend on how many mAh they output and the prices of batteries with similar mAh are very similar.

A battery charger can often be bought in a pack with the batteries for a couple more bucks. Also rechargers are easy to find for cheap in many stores.

Microcontroller:

- Roboduino/Arduino UNO 2011 ATmega328 (ebay ~ cost $23)

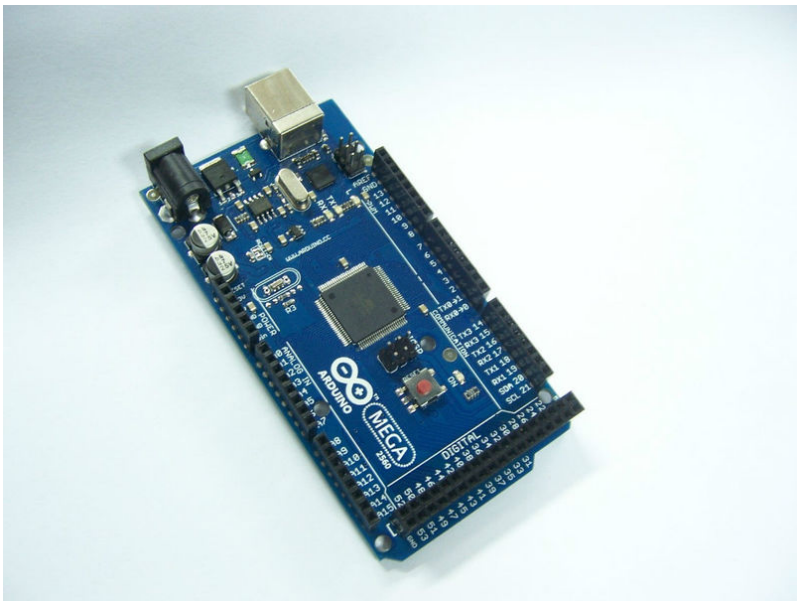


Features :

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by bootloader
SRAM	1 KB (ATmega168) or 2 KB (ATmega328)
EEPROM	512 bytes (ATmega168) or 1 KB (ATmega328)
Clock Speed	16 MHz

- Arduino Mega2560 (ATMEGA2560 / ATMEGA8U2) (ebay.com cost ~ $35) Preferred.

We will probably use this chip for programming since Dr. Lima and some of our group members have experience using this chip.



Features:

- ATmega2560 microcontroller
- Input voltage - 7-12V
- 54 Digital I/O Pins (14 PWM outputs)
- 16 Analog Inputs
- 256k Flash Memory
- 16Mhz Clock Speed

Both chips using free program to program on the second one has more peripheral.

EEG Sensor:

Neurotode EEG Sensors - 60 pack, .7 inch diameter, don't contain latex, has a standard snap connector, Cost - $42

EEG Silver Cup Sensor Kit - DIN Connection, two 8 mm silver cup style sensors, 2 silver ear clip sensors. Cost - $70

E21-9S Disc Electrode- 9 mm tin cup, 1.5 mm DIN connector, 48 inch lead wire

Cost - $10 (1 sensor)

Products as shown on bio-medical.com

Since we are trying to build the cheapest model we possibly can, while still maintaining integrity, price may be the biggest issue. There are many different types of eeg sensors and ear clips gold and silver ones being quite expensive at around $70 or $80 dollars.

Filter:

We found several different low pass filters available commercially but they are so expensive that it's not even useful to put them on. So unless we find a good affordable filter, we are simply going to use a common low pass filter design for eeg's. We should be able to get most of the parts for that from the department, so the cost should be fairly low.

Amplifier:

We will probably use an instrumentation amp to amplify the single channel filtered input before it gets processed. The instrumentation amp should be able to give the necessary high gain needed along with having a high input impedance. A useable model should be available through the department, but if not the cost should be fairly low, (around $1 a piece for the chip).

Stimulator:

GE0834 Vibrator Vibration Motor. On ebay it sells for around $4

Vibrating Cell Phone & Pager DC Micro Motor 1.5v - 4v 3v 3vdc Vibrator. Cost - $3 -4

Piezo buzzer, also has a cost of a couple dollars. We should be able to get it from the department. A buzzer should almost certainly be able to wake someone up from their sleep because they are horribly loud.

Budget:

Unit	Cost per unit	Quantity	Total Cost
Duracell DC1500B4N	~$9	1	$9
GE0834 Vibrator	~$4	1	$4
EEG Electrodes	~$50	1	$50
ATmega328	$23	1	$23
Piezo Buzzer	~$3	1	$3
Filter Parts	Less than $20		$20
Amplifier	~$2 through dept.	1	$2

Total expected cost - $110

Summary:

There are a lot of options that we won't know whether or not they are good enough to work until we actually try them. Making this system reliable and cheap is going to be the biggest challenge in the design process. Without a doubt some changes will have to be made along the way. This budget should be a fairly good estimation of the money required to design and build this system. By the end of the semester we plan on being able to capture useful data from the brain and have some analysis done on the data.

This system will make independent dream research more productive and much more feasible financially. By decreasing the requirements for the what the end product actually needs to do we should be able to make a consumer ready product that anyone can afford.